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A LABORATORY APPARATUS AND PROCEDURE FOR TESTING AQUEOUS SPRAY SUSPENSIONS AS INSECTICIDES

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There are two general types of laboratory apparatus for applying spray suspensions. In one type the spray is applied to an uneven surface such as a potted plant. In the other type, described below, the suspension is applied to a relatively smooth surface such as a leaf or section of a fruit. The spray is evenly distributed, preferably as small drops, to prevent large accumulations of the suspended material from forming in certain areas before the spray has dried. If a suspension is sprayed to form a uniform distribution of drops of the same volume closely packed together but not coalescing, a relatively uniform deposit should be obtained if each drop is considered as a unit area. Therefore, if the area consumed by the insect is greater than the area covered by a single drop, it is probable that the insect will ingest a proportionate dose of insecticide. This may not be true, however, if the insect consumes a smaller area, because within an individual drop of spray the deposit may not be uniform, owing to the settling of the insecticide within a drop and other factors.

SPRAY AND SETTLING CHAMBERS

The spray and settling chambers consisted of a cylinder or tower (fig. 1) 8 feet in height and 2 feet in diameter. Light was admitted through a 10-inch-square celluloid window (B) in the removable wallboard top (A) of the tower. The floor (G) of the spray chamber (C) was 5 feet from the top and was made of half-inch-mesh galvanized screen. Below this screen was the settling chamber (R), which stood on the floor of the laboratory (T). The intake of a blower (S) for exhausting the contents of the tower to the outside of the building opened near the floor. The inner surface of the spray tower was of linoleum and the outside covering of building paper. The two surfaces were separated by a 1-inch air space for insulation. A removable door (F) 6 inches wide extended 10 inches above and below the screen floor (G), and two 4-inch-square observation windows (E) were located 15 inches above the screen floor. The tower was supported by passing through and being securely attached to a table (Q).

SPRAYER

The sprayer (K) was a modified air brush manufactured for applying paint. The liquid orifice was 1.75 mm. in diameter and was surrounded by the air orifice. The sprayer operated as an atomizer and drew the liquid up through a straight copper tube (L) about 4 mm. in diameter. The sprayer, as purchased, had a bend and a small chamber in the liquid line, but it was replaced by the straight tube because the larger particles of insecticide collected near this bend and also in the small chamber. The sprayer was mounted below the screen floor so that it discharged upward at about the level of this floor. Three setscrews permitted accurate adjustment of the direction of discharge. Just below the sprayer was a container (M) for the spray suspension, which was held in place by a threaded jar top. From this position the liquid was raised vertically through the suction tube and sprayed out so that settling in the tube was practically eliminated. When the air pressure was shut off, the material in the tube fell back into the container. Air pressure at 50 pounds per square inch operated the sprayer. This could be turned on and off at a valve (O) located outside the spray tower.

AGITATION OF SPRAY

The agitator used in preliminary tests gave variable deposits. For example, chemical analysis revealed that a fine fraction of paris green deposited 14, a medium fraction 26, and a coarse fraction 70 micrograms per square centimeter, when equal weights of the three fractions were added to 100 ml. of water. 1/ The agitator adopted gave deposits of 16.9, 17.2, and 18.2 micrograms per square centimeter for the fine, medium, and coarse fractions, respectively. These figures show some increase in deposit with increase in particle size, possibly due to the suction pipe of the sprayer opening near the bottom of the spray container. To obtain uniform deposits of paris green, the amount of each fraction used was adjusted to give the desired deposit. As many experimental materials that are tested as insecticides settle or rise rapidly when suspended in water, the data given demonstrate that the efficiency of the agitating system may determine the deposit of insecticide obtained.

1/ The authors wish to thank C. C. Cassil, C. M. Smith, and others in the Division of Insecticide Investigations for preparing these fractions of paris green and the chemical analysis given above, and also for materials and suggestions on procedure used in determining the deposits given under "Uniformity of Deposit."

The spray suspension was agitated by a rubber blade which rotated in a horizontal plane near the bottom of the container (M). This blade was mounted on a vertical shaft (J), which was driven by a flexible shaft (I) from a variable-speed motor (H) mounted outside the spray tower. The agitator speed was adjusted to keep the materials suspended without forcing air bubbles into the spray suspension.

UNIFORMITY OF DEPOSIT

Following preliminary tests to center the spray discharge, several applications were made on six pairs of glass slides 8 by 10 cm. arranged in two concentric circles 10 cm. apart on the floor of the chamber. The average deposit on the slides in the inner circle was 22 percent greater than on those in the outer circle.

To obtain a uniform deposit on leaves, after half the spray suspension had been applied, the position of the leaves was reversed before the other half was applied. The leaves were then turned over and the other side was treated in a similar manner.

To check further on the uniformity of the deposit at different positions, spray applications were made on six glass slides arranged on the screen floor in a single circle equidistant from the center and the outside wall. After six to nine replications of each of three fractions of paris green—fine, medium, and coarse—the average deviation from the mean deposit of all fractions was 7.2 percent, and the average individual variations from the mean deposit in each application ranged from 1.9 to 14.2 percent. As these tests varied both in the concentration and the particle size of the insecticide used, they appear to give some idea of the variation that might be expected in this method.

Casual observations had shown that near the center of the spray floor and near the wall the deposits were not uniform.

PREPARATION OF LEAVES FOR SPRAYING

Flat leaves, such as those of certain varieties of turnips and beans, were cut and the petioles inserted in vials of water through one-hole stoppers. The petioles fitted in the stopper tight enough so that air entered the vials as the leaf withdrew the water but the water did not leak out (fig. 2, A). The leaves with the vials attached were placed on wooden paddles of approximately the same shape and size as a single leaf. The vial was attached to the paddle with rubber bands, and the leaf blade was held in a horizontal position by the points of pins that extended up from the paddle. When the leaf was turned over to spray

the other side, the deposit on the sprayed surface was not materially disturbed, as it was not heavy enough to drain down the pins. When the exact area eaten by bean beetles was desired, the under surface of the bean leaves was covered with a piece of flannel. The nap of the flannel and the pubescence of the bean leaves held this cloth firmly in place, preventing the insects from feeding on the lower surface.

OPERATION OF THE SPRAY APPARATUS

Leaves were placed on the screen floor in a circle equidistant between the spray nozzle and the wall of the spray chamber. When chemical analyses of a deposit were desired, two or more glass slides, 8 by 10 cm., were laid between the leaves. The door was closed and the vent through the exhaust blower was opened but the blower was not started. The valve in the air line was opened, and the spray stream rose in the chamber and fell back onto the leaves on the screen floor. The screen permitted the spray and air to pass into the settling chamber below and from there to the outside with little interference, and thus reduced the formation of eddy currents which would tend to disrupt the uniform deposition of the spray. When half the amount of liquid that would produce the desired deposit had been sprayed, the air was shut off and the spray allowed to settle for 1 minute. The top of the tower was then raised slightly and the blower run for 30 seconds to remove any spray that might have settled unevenly when the leaves were being moved, and also to reduce the health hazard to the operator. The position of the leaves was then reversed. The quantity of spray suspension used was replaced in the container and the operation repeated to finish the spray deposit on one surface of the leaves. The leaves were then turned over and the other side was sprayed, except when one side of the leaves was covered with cloth.

INFESTING THE SPRAYED LEAVES

Either Mexican bean beetles or southern armyworms were used as test insects.

When Mexican bean beetles were used, a dry sprayed bean leaf with the vial of water on its petiole was placed in a 6-inch Petri dish together with 10 to 20 adults or larvae, which were confined by a screen cover. Mortality counts were made after 24, 48, or 72 hours, and subsequently at 48- or 72-hour intervals until the mortality rate approximated that occurring among insects on untreated foliage. The treated leaves were replaced by fresh untreated ones after 48 or 72 hours and subsequently as the insects needed food. The leaf surface consumed was measured by comparison with millimeter-ruled paper.

When southern armyworm larvae were used as test insects, turnip or collard leaves were sprayed. As the southern armyworm tends to be cannibalistic, especially when poisoned, the larvae were confined individually (fig. 2, B-F). The blade of a sprayed leaf was laid on 16-mesh screen tacked to a 12-inch length of 6-inch board. The vial was fastened to the board with a rubber band. A screen cage 2 1/4 by 6 1/4 by 3/4 inches, divided into 5 sections 2 1/4 by 1 1/4 inches, was placed on each side of the midrib of the leaf. The ends of the screen wires that formed the sides and partitions pierced the leaf blade and made close contact with the screen attached to the board below the leaf. The sides of the cages had been treated with an acetone solution of celluloid to add rigidity and also to separate the larvae more completely. One fifth instar was enclosed in each section of the cage, which was then placed on the leaf and secured with wooden strips and rubber bands. Mortality counts were made in the same manner as for Mexican bean beetles.

SUMMARY

A laboratory apparatus and a method of applying spray suspensions are described. The spray stream is discharged vertically upward and the drops of spray fall back on the surface to be treated. This method gives a relatively uniform deposit of spray material, and a number of excised leaves can be treated simultaneously. A cage for confining a number of larvae individually on an intact leaf is described.

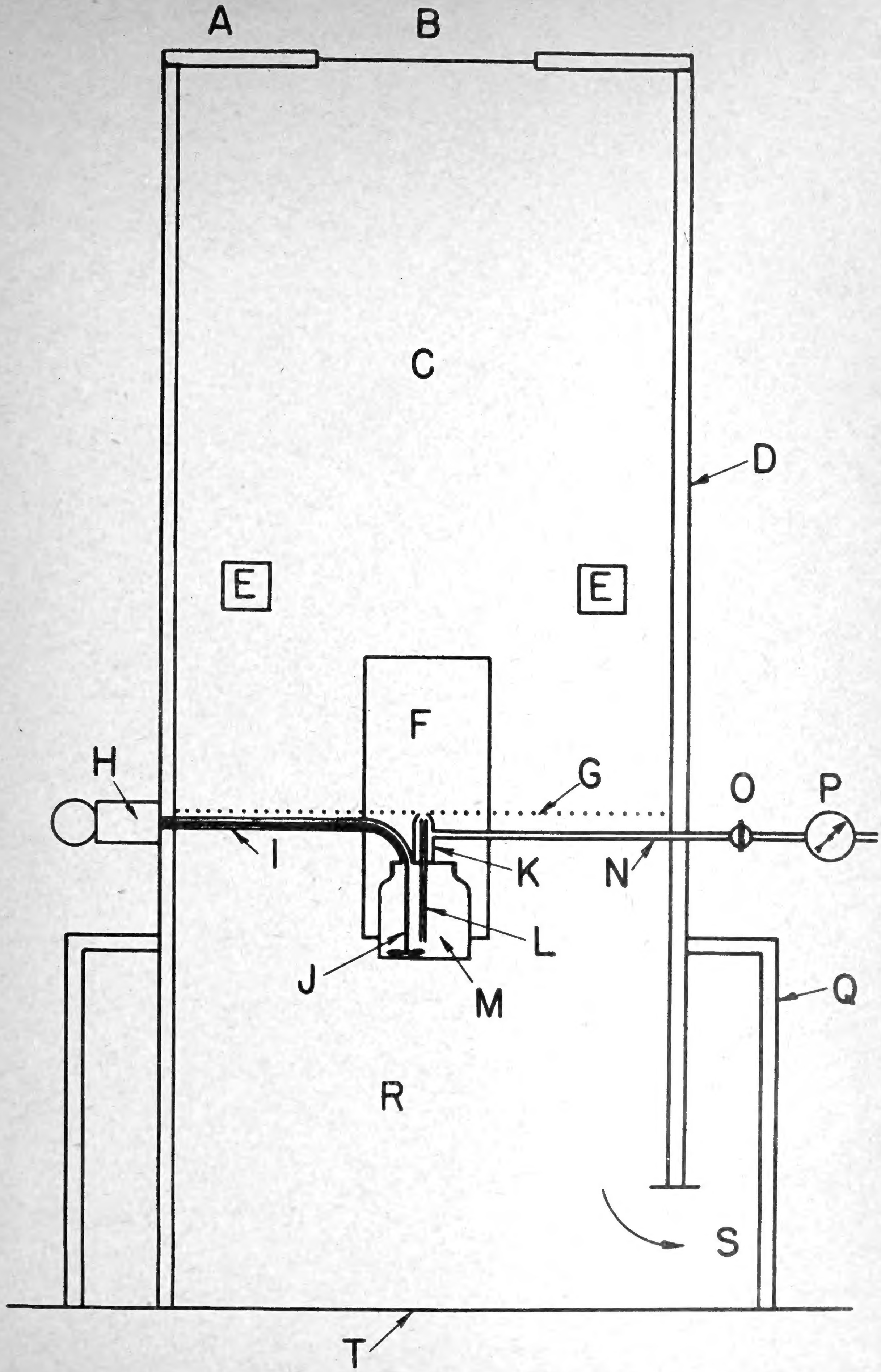

Figure 1.—Diagram of spray tower. See pages 2 and 5 for names of parts that are lettered.

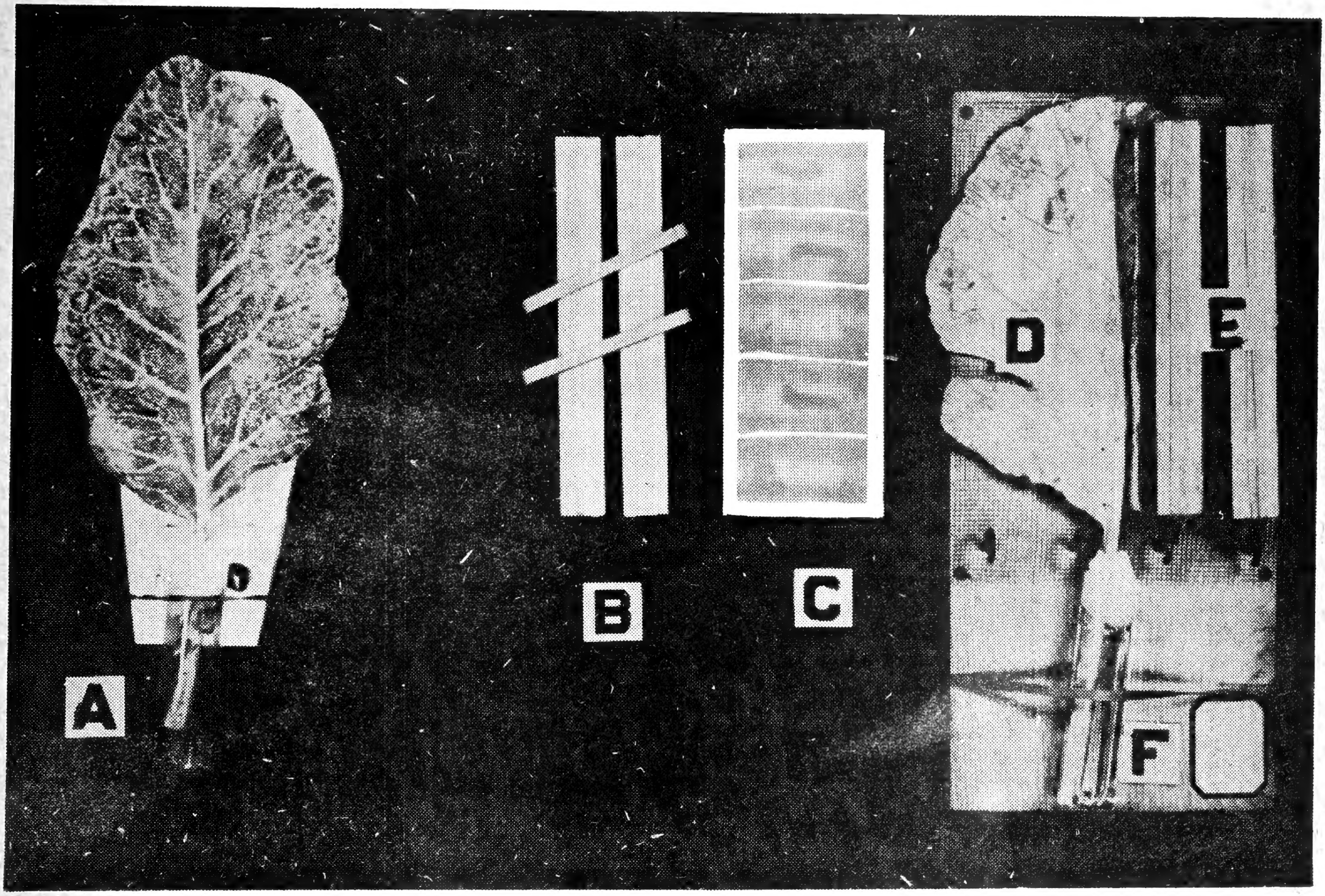

Figure 2.--Caging larvae individually on a sprayed leaf. A, Leaf in position to be sprayed; B, wooden strips and rubber bands to hold cage on leaf; C, cage with five larvae, ventral view, ready to invert and place on leaf in position D; E, second cage already in place; F, baseboard with leaf and one cage in place.